DIVERSION EFFECTS ON FISH

APPENDIX B

CALFED ALTERNATIVE EVALUATION FOR STRIPED BASS

DIVERSION EFFECTS ON FISH

CALFED ALTERNATIVE EVALUATION FOR STRIPED BASS
NARRATIVE

Draft - June 23, 1998

Introduction-Evaluation Team and Process:

The CALFED task of evaluating diversion effects on fish was divided into species subcommittees. The striped bass subgroup met twice and evaluated the diversion impacts of the alternatives based on information provided in the CALFED Phase II report and recent operation studies.

The striped bass evaluation is based on a review by biologists with knowledge of the striped bass population and historic relationships of egg and larva distribution and abundance, young-of-the-year abundance, and adults in relation to estuarine conditions and historic changes. Participants on the work team are Stephani Spaar (Department of Water Resources), David Kohlhorst, Lee Miller, Kevan Urquhart, and Don Stevens (Department of Fish and Game). Elise Holland (Bay Institute) was a member of our team but was unable to attend the meetings when the matrices of diversion effects were developed. This report is the result of the interactions of this group.

Methods:

We completed matrices (pages B10-B17) for: existing conditions, no action conditions (projection of increased demand on existing facilities), common programs, diversion alternatives 1, 2, and 3 and full restoration. The matrices were used as a guide and checklist to assure our consideration of the relevant diversion issues. We adopted a scale of -5 to +5 to express the relative impact of effects identified in the matrix as major components that would affect striped bass in relation to water diversions. Evaluations were based on qualitative assessments of the degree to which operations affect the population. We used two CALFED operations draft studies to evaluate future operations (CALFED 1998). Entrainment impacts included predation in Clifton Court, losses related to screen inefficiencies, handling and release site mortality. However, these were not separately scored but were included in our evaluation. After the matrix scoring was completed, we assigned relative weight factors to each component of the matrix. We also limited the fall-winter periods to combinations of months which became self-weighting in the process since striped bass during these periods generally tend to be less vulnerable to diversions.

Existing conditions are the diversions as operated currently with the 1995 Water Quality Control Plan Delta Standards in effect. An evaluation of full restoration conditions relative to the existing conditions and alternative choices was made to assess the extent to which the striped bass population would be restored with the proposed alternatives. All matrices were completed using the CALFED operations studies provided. This was a judgmental process with no striped bass modeling, data analysis, or quantitative assessments because time constraints did not permit more rigor. In many cases we cannot be certain how the population might respond to the new conditions being proposed.

Results

The following questions were evaluated.

1. Which life stages are most sensitive to diversion effects under no action and alternatives 1, 2, and 3? When and where are they most affected?

Existing Conditions

Diversions in the Delta have had a major impact on the striped bass population whose nursery area historically has been the Delta and Suisun Bay. (Chadwick et al. 1977, Stevens, et al. 1985, IESP 1987, Department of Fish and Game 1992). The decline in both the young of the year (YOY) measure of abundance (38 mm index) and adults have been linked to the effects of entrainment losses in the Delta. Diversion effects on striped bass and other fish were empirically demonstrated in 1977, a severe drought year, when flows were so low that export pumping was minimal or ceased for much of the year because of water quality problems related to low freshwater inflow. As a result there was an accumulation of striped bass in the Delta made evident by the large number of striped bass salvaged when export pumping did resume when Delta inflow increased in December. Such accumulations of fish in the Delta were not evident in either 1976 or 1978, years when export pumping was not curtailed in the summer (Table 1).

Table 1. Export pumping rates and delta smelt and striped bass salvage by the State Water Project (SWP) in 1976, 1977 and 1978. Data prepared for CALFED by H. K.Chadwick 1998.

	1976-1977			1977-1978			1978-1979		
	SWP Pumping-00's cfs	Delta smelt 000's	striped Bass 000's	SWP Pumping 00's cfs	Delta Smelt 000's	Striped Bass 000's	SWP Pumpin g-00's cfs	Delta Smelt 000's	Striped Bass 000's
May	6	102	16	11	3	0	9	4	1
June	3	277	717	3	3	53	33	36	633
July	3	371	639	3	43	367	34	1	1,115
Aug	21	68	156	2	6	12	40	2	307
Sept	35	1	13	2	18	1	35	0	18
Oct	14	0	2	1	3	0	20	0	173
Nov	16	0	32	9	0	22	22	0	171
Dec	10	0	20	22	55	63	27	1	172
Jan	33	7	58	60	134	590	13	0	34
Feb	19	2	10	61	54	306	16	1	8

More recent analyses also support these findings. Recently Kimmerer, et al. manuscript, suggests that density-dependent survival may moderate the effects of flows and diversions on year class strength. While relative year class strength often changes between YOY and recruitment at age 3, density-dependent survival does not fully compensate for lower numbers of YOY striped bass. The adult population was 1.8 million in early 1970's and has declined to about 0.5 to 0.7 million in the 1990's. This decline in adults is consistent with the general declines in egg abundance and the 38-mm index of young abundance. Compensation is insufficient to offset the decline in egg production which has ranged from 319 billion in 1969, to 31 billion, in 1996. Hence, there has been an order of magnitude decline in egg production versus only a 2/3 decline in the number of adults. Kimmerer, et al., manuscript, states "the median losses to pumping were estimated at 33 percent, a substantial fraction of the total mortality and losses were often much higher."

The Oakridge National Laboratory Individual Based Model results (draft report is in preparation by Kenny Rose) indicate that diversions and food supply variables together account for the decline in striped bass. However, if only diversions were set at pre-bass decline levels in the model, the population would recover to a stable population of about 1.5 million adults which, though not the historic measured high of 1.8 million, is evidence of the importance of diversions in driving the striped bass population decline. Food by itself in the model caused only a decline to 1.5 million adults but when both food and diversions are included the population declined to 0.5 million. These model runs were made with density-dependence accounted for in the model.

Apparent adult mortality has also increased in recent years and increased ocean migrations which result in straying to other estuaries and possibly intermittent returning to this estuary to spawn has been suggested as an explanation by Bennett, ms. The decline in egg production appears to be a combination of fewer adults due to less recruitment and a greater decline in older fish due to higher mortality, although the cause of the increase in mortality is unknown.

No Action.

Striped bass eggs and larva and juveniles are the life stages directly impacted by water diversions in the Delta during the first year of life from April through the fall and sometimes during winter. The impact on eggs, larvae and young juveniles occurs from April to July with further impacts on juveniles through the summer and fall. These impacts would continue under the No Action Alternative. Total exports under the No Action Alternative during the spawning and nursery season are roughly the same as average existing conditions (CALFED 1998, Appendices A, E). Although average annual exports for this alternative are 6.5 % higher than existing exports, most of this increase occurs from August to March. The added impact on striped bass during this period tends to be relatively small in wet years and greater in dry and critical years because of longer fish residence time in the Delta when flows are low.

It is unclear whether increased exports over current levels would further deplete the population of young striped bass in the Delta, since they may already be nearly depleted there under current export levels in dry and critical years. Under current conditions the population is likely to continue to decline in the absence of a hatchery stocking program (Department of Fish and Game 1998). In recent years, young striped bass abundance has remained low despite higher than average delta outflows and low export rates, both of which are conducive to strong year classes. The most apparent cause is the continuing decline in egg production caused by average lower recruitment since the 1970's due to entrainment losses and relatively fewer, older, more fecund adults as a result of lower recruitment and an increase in adult mortality rates.

Alternative 1.

Under Alternative 1, entrainment of eggs, larvae, and juveniles in the south Delta would continue, but additional juveniles would be salvaged because of improvements in fish facilities and elimination of Clifton Court pre-screen losses. The closure of the cross channel gates through the spawning season from April to June for winter-run chinook salmon protection, would reduce the diversion of Sacramento River striped bass eggs and larvae in comparison to periods when the cross channel gates were open in years before the winter-run criteria went into effect. However, closing these gates may lead to greater negative flows in the San Joaquin River. As in the past, eggs and larvae would move across the Delta from the Sacramento River through Georgiana and Three-mile sloughs and some would be entrained at the export facilities.

Alternative 2.

Under Alternative 2, increased numbers of eggs and larvae would be diverted and entrained from the Sacramento River because fish screens at the Hood diversion would be inadequate to screen these stages. At the Clifton Court diversion, eggs, larvae, and juveniles would continue to be entrained; additional juveniles would be salvaged because of improvements in fish facilities and elimination of Clifton Court pre-screen losses.

However, adults would be adversely affected because they would be attracted by the high proportion of Sacramento water in the Mokelumne River and hence blocked from completing their migration by the fish screen at Hood. This problem requires a feasible means of fish passage. Apparently, it is possible to trap and pass striped bass over such structures but whether it is feasible, advisable and cost effective to move several hundred thousand striped bass around a structure in a short time, remains to be explored. If trapped adults spawn in the Mokelumne River in response to rising temperatures before they are passed around the fish screen, most of their progeny would be highly vulnerable to Delta diversions, although tidal dispersion at the junction of the San Joaquin River and Mokelumne River might enable some to escape initial entrainment. Estimates of the percentage reduction in the population of striped bass eggs and larvae in the Delta are substantial under existing conditions. Estimates of reduction in low flow years range from 73.5 to 99.6 percent (DFG 1992). Population reduction would likely increase if Sacramento River bound fish spawn in the Mokelumne River and that water goes directly to the export pumps.

It is unknown what proportion of the population might use this channel to attempt to access the Sacramento River. If flows diverted at Hood are a large proportion of the Sacramento flow, as might occur in dry years, more fish might be attracted to the Mokelumne River as a corridor to the spawning grounds. Some striped bass tagged and released in the San Joaquin River are commonly recaptured within a few weeks from the Sacramento River above Sacramento, but it is unknown which pathways from the San Joaquin River to the Sacramento River are most important.

Alternative 3.

Increased numbers of eggs and larvae could be diverted and entrained from the Sacramento River because fish screens at the Hood diversion would be inadequate to screen these stages. However, a higher proportion of the juveniles entrained would be salvaged because of improvements in fish facilities and elimination of Clifton Court pre-screen losses. The magnitude of the diversion of eggs and larvae from both the Sacramento and San Joaquin rivers, as well as eggs, larvae and juveniles from the San Joaquin, depends on operation of the facilities. For example, a temporary reduction in diversion at Hood during the striped bass spawning season would reduce diversion of eggs and larva from the Sacramento River and provide transport flow to move young bass to the nursery areas downstream. If diversions are not curtailed entrainment of egg and larva will be high and transport flows will likely be inadequate. Adult migrations would not be affected as for Alternative 2 because the facility is isolated. When diversion occurs in the south Delta, some entrainment would continue for eggs, larvae, and juveniles from the San Joaquin River and through other Delta channels. However, because QWEST flows would be improved over existing conditions and less water would be diverted from the south Delta, we expect less entrainment of striped bass and improvement of nursery habitat in the Delta.

2. Can diversion effects in the South Delta be offset by habitat improvements and other common program actions?

Striped bass can use various habitats to rear, including shallow water. Any improvements in habitat such as an increase in tidal marshes in Suisun Bay, San Pablo Bay or in other areas secure from entrainment effects could help striped bass; however, there is no way to determine, a priori, if such habitat change would offset entrainment losses and indirect mortality from transport flow reductions on the Sacramento River. As stated above, south Delta diversions have a major impact on the population so habitat improvements would need to have a large impact to offset existing conditions.

Reduction in toxicants may improve striped bass survival, but toxicants have not been identified as a major controlling factor for the striped bass population. Hence, population increases resulting from this program would likely be small.

Some common programs may adversely affect striped bass and other fish populations if nutrients and turbidity are reduced. For example, if nutrients, carbon input, and primary production are decreased this would reduce the food supply for fish. Turbidity reduction could result in increased predation on young striped bass and other fish. While these common programs are difficult to evaluate, some would likely be an improvement over existing conditions.

3. To what extent can alternatives 1, 2, and 3 offset diversions effects as presently configured?

All three alternatives screen the intake to Clifton Court Forebay which reduces predation and other losses now occurring in Clifton Court. The No Action choice would continue these losses. Screening of agriculture diversions would reduce losses of some young striped bass which are beyond the egg and larva stage.

Alternative 1.

Alternative 1 offers marginally improved conditions for striped bass compared to existing conditions by elimination of predation on young striped bass in Clifton Court Forebay. However, striped bass in the Delta would still be exposed to large potential entrainment losses due to screen inefficiencies, handling mortality, and indirect losses. This alternative maintains flows in the Sacramento River below Hood as occurs under present conditions, providing for faster transport of striped bass out of the river and into the lower river and Suisun Bay than either Alternatives 2 or 3. Striped bass survival between egg and larva stages increases with increased river flow (IESP 1994).

Alternative 2.

Because the Hood diversion would reduce transport flows for larvae, potentially result in significant numbers of adults spawning in the Mokelumne River, and entrain large numbers of eggs and larvae from the Sacramento River, this alternative would provide worse conditions for striped bass than existing diversion conditions. The extent of these impacts is uncertain given the unknowns associated with the above. How these facilities are operated to minimize impacts during the spawning season is important.

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If only a few adults were blocked from migrating to the Sacramento River at Hood, Alternative 2 would likely decrease the entrainment of striped bass in the South Delta by creating more positive net flows in the San Joaquin River. Operation studies indicate that net San Joaquin River flows at Antioch would be positive for all months of the year and in April-July would be about double the No Action conditions or conditions under Alternative 1. However, these flows are still small relative to the tidal volume. On average, reverse flows would no longer occur on the San Joaquin River (based on operations studies: QWEST, 1921-1994; Flow at Antioch, 1975-1991).

Alternative 3.

The use of Alternative 3 in lieu of existing conditions for times of the year other than the striped bass spawning period would greatly reduce the entrainment losses now occurring in the south Delta. Additionally, because it is an isolated facility, it would not attract adult fish and this obviates the need to deal with the problem of passing fish past a fish screen at Hood as in Alternative 2. The diversion of eggs and larvae during the spawning season and reduced transport flows in the Sacramento River below Hood would decrease the survival of eggs and larvae in that river reach. If the facility were operated to minimize such diversions when striped bass spawn and south Delta diversions were also minimized during the spawning and nursery period, this would provide greatly improved conditions for striped bass. Positive flows in the San Joaquin River would be good for striped bass spawning in the San Joaquin River; it would move them west to better nursery conditions and away from entrainment and improve the Delta as nursery habitat for striped bass. This alternative scored highest in the matrix exercise.

5. What is the risk and chances of success of species recovery for each alternative?

The striped bass population has been declining. The adult population is affected by reduced recruitment as a result of early life stage losses without sufficient density-dependent survival (compensation) to maintain the numbers of adults that were historically present. Although some compensation is apparently occurring between the summer abundance in the first year of life and recruitment at age 3, the population of adults, which numbered 1.8 million in the early 1970's, has declined to about 700,000 presently. Recovery cannot occur under the No Action Alternative. Alternatives 1 and 2 appear to exacerbate present striped bass population stresses related to using the Delta as a water export conduit. Alternative 3 still falls short of full restoration to historic population levels (see Appendix matrix, page 8), largely because water demands exclude achievement of full restoration conditions. Alternative 3, if operated in a manner which minimized entrainment of young striped bass, provides the best opportunity for some restoration of the population.

6. What increment of protection or improvement for fish species will be provided by other programs such as the Central Valley Project Improvement Act(CVPIA), biological opinions, etc.?

This is difficult to evaluate since no water has been firmly committed to any striped bass restoration scenario. It is unlikely that the 800,000 acre feet of water allocated under the CVPIA doubling of anadromous fish will cause a doubling of striped bass given the existing export conditions and diversion impacts.

7. **What degree of benefit and impact will the common programs provide?**

The common programs will likely provide some benefits for young striped bass, but these are difficult to evaluate. Screening of small Agricultural diversions would reduce mortality of young striped bass. Planned increases in the amount of tidal marsh habitat for nursery areas adjacent to Suisun Bay and San Pablo Bay could increase survival of young striped bass. Reducing point and non-point sources of toxic chemicals and metals could improve conditions for all life stages to some degree, however, present population effects of toxicants have not been demonstrated. Reduction of organic input and decreasing turbidity may adversely affect striped bass production.

8. **What are the direct and indirect effects on fish populations resulting from each alternative and what is the expected response of the populations to these effects?**
Covered in answers to questions 1-6.

9. **What Sacramento River flow is required below a Hood diversion to protect salmon, striped bass and delta smelt?**
Transport flows to move striped bass into the estuary are important. When large numbers of striped bass eggs and larvae are moving down the Sacramento River, diversion should stop or be minimized to reduce the impact of entrainment and to assure sufficient transport flow to promote the survival of larvae. We recommend that flows be maintained at a high enough level to transport eggs to Collinsville to Rio Vista reach of the river within 4 days after passing Hood. Reduction of flows below Hood to less than what now occurs when I street flows are 13,000 cfs or greater would be detrimental to young striped bass.

10. **What survival rate can be expected for striped bass eggs and larvae and delta smelt passing through Sacramento River screens and pumps in Alternative 2?**
We would expect that most striped bass eggs and larvae would be entrained with water diverted at Hood and channeled to the pumping plants; therefore, survival would be very low. Some would likely be caught in the tidal volume and move back and forth in the San Joaquin River and of these some might avoid entrainment by moving beyond the influence of the pumps, depending on San Joaquin River net flows and dispersion in the lower San Joaquin River. However, as previously indicated, net flows are low relative to the tidal volume which suggests that residence time within the influence of the pumps will be long. Modeling of the hydrodynamics might be helpful to estimating the proportion of striped bass larvae and juveniles lost to pumping.

11. **Should there be a screen on the Sacramento River intake of Alternative 2?**
A screen for striped bass eggs and larvae, if feasible, would likely be very expensive and difficult to maintain in a debris free state. A screen for salmon juveniles or young striped bass would also be a negative factor if it traps striped bass adults migrating through the Mokelumne River to the Sacramento River spawning grounds.

<u>12.</u> **<u>What are the logical stages for a preferred alternative?</u>**
Alternative 3 is the preferred alternative for striped bass. It is not clear how this could be built in stages based on biological considerations.

Uncertainties

There are many uncertainties in this evaluation, both large and small. Even with further data exploration, there is much that would remain speculative in our assessment of potential benefits and detriments. First, there is the uncertainty regarding how much striped bass entrainment losses will be reduced and access to nursery areas enhanced with positive downstream flows rather than reverse flows in the lower San Joaquin River. Similarly, when Sacramento River flows necessary for larva transport are greatly reduced below Hood, how much will this affect the survival of striped bass left in the river? At this location, transport flows obviously become more important in years of low inflow. The proportion of the adults that would use the Mokelumne River as a migration corridor to the Sacramento River spawning ground is unknown. If that proportion is small, it will have a minor effect, but if it is large, it will have a major negative impact.

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Matrix for Calfed

CALFED Alternatives evaluation for striped bass -page 1

Diversion Effects on Striped Bass-Existing conditions assumes Delta Accord

Effects	wt.	Oct-Nov	Dec- Mar	Apr	May	June	July	Aug	Sep	sum	comments
Entrainment	10	-1	-1	-2	-3	-3	-4	-2	-1		June to Aug more predation on juveniles.
Predation mortality-CCF + return											
Entrainment losses											
Handling mortality											
Food supply	3	0	0	0	0	-1	-1	-1	0		Diversion effects on zooplankton appear small
Shallow/inshore habitat- offsetting div.	1	0	0	0	0	0	0	0	0		
Water quality (toxics)	1	0	0	0	0	-1	0	0	0		
WQ (salinity) affecting SJR spawning	1	0	0	-1	-1	0	0	0	0		
Agricultural diversions	3	0	0	-1	-2	-2	-1	0	0		Diversions vary with water year type.
Hydrodynamics-Sacramento R. trans	3	0	0	-1	-1	-1	0	0	0		
Hydrodynamics-San Joaquin flow	3	0	0	-1	-1	-2	-2	-2	-1		Diversions vary with water year type.
Hydrodynamic- Xdel fl- G. sl and 3 mi.	3	0	0	-1	-1	-1	0	-1	0		
Unweighted total		-1	-1	-7	-9	-11	-8	-6	-2	-45	
life stage		juv	juv	e & l	e & l	e & l, juv	l & juv	juv	juv		

Diversion Effects on Striped Bass- No Action

Effects		Oct-Nov	Dec- Mar	Apr	May	June	July	Aug	Sep		comments
Entrainment	10	-1	-2	-2	-3	-3	-4	-2	-1		shaded cells indicate change from existing conditions
Predation mortality-CCF											
Entrainment losses											
Handling mortality											
Food supply	3	0	0	0	0	-1	-1	-1	0		
Shallow/ nearshore habitat	1	0	0	0	0	0	0	0	0		
Water quality (toxics)	1	0	0	0	0	-1	0	0	0		
WQ (salinity) affecting SJR spawning	1	0	0	-1	-1	0	0	0	0		
Agricultural diversions	3	0	0	-1	-2	-2	-1	0	0		
Hydrodynamics-Sacramento R. trans	3	0	0	-1	-1	-1	0	0	0		
Hydrodynamics-San Joaquin flow	3	0	0	-1	-1	-2	-2	-2	-1		
Hydrodynamic- Xdel fl- G. sl and 3 mi.	3	0	0	-1	-1	-1	0	-1	0		
Unweighted total		-1	-2	-7	-9	-11	-8	-6	-2	-46	
life stage		juv	juv	e & l	e & l	e & l, juv	l & juv	juv	juv		

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CALFED Alternatives evaluation for striped bass -page 2

Diversion Effects on Striped Bass-common programs

Effects	wt.	Oct-Nov	Dec- Mar	Apr	May	June	July	Aug	Sep		comments
Entrainment	10	0	0	0	0	0	0	0	0		
Predation mortality-CCF											
Entrainment losses											
Handling mortality											
Food supply	3	0	0	0	0	0	0	0	0		
Shallow/inshore habitat- offsetting div.	1	0	0	0	0	0	0	0	0		difficult to assess for striped bass/ need more info.
Water quality (toxics and nutrients)	1	0	0	0	0	0	0	0	0		water quality for drinking water not necessarily good for fish
WQ (salinity) affecting SJR spawning	1	0	0	0	0	0	0	0	0		
Agricultural diversions	3	0	0	0	0	0	0	0	0		
Hydrodynamics-Sacramento R. trans	3	0	0	0	0	0	0	0	0		
Hydrodynamics-San Joaquin flow	3	0	0	0	0	0	0	0	0		
Hydrodynamic- Xdel fl- G. sl and 3 mi.	3	0	0	0	0	0	0	0	0		
Unweighted total		0	0	0	0	0	0	0	0	0	
life stage		juv	juv	e & l	e & l	e & l, juv	l & juv	juv	juv		

Diversion Effects on Striped Bass- Alternative 1

Effects		Oct-Nov	Dec- Mar	Apr	May	June	July	Aug	Sep		comments
Entrainment	10	-1	-1	-2	-3	-2	-3	[illegible]	-1		shaded cells indicate change from existing conditions
Predation mortality-CCF											
Entrainment losses											
Handling mortality											
Food supply	3	0	0	0	0	-1	-1	-1	0		
Shallow/ nearshore habitat	1	0	0	0	0	0	0	0	0		
Water quality (toxics)	1	0	0	0	0	-1	0	0	0		
WQ (salinity) affecting SJR spawning	1	0	0	-1	-1	0	0	0	0		
Agricultural diversions	3	0	0	-1	-2	-2	-1	0	0		
Hydrodynamics-Sacramento R. trans	3	0	0	-1	-1	-1	0	0	0		
Hydrodynamics-San Joaquin flow	3	0	0	-1	-1	-2	-2	0	0		
Hydrodynamic- Xdel fl- G. sl and 3 mi.	3	0	0	-1	-1	-1	0	-1	0		
Unweighted total		-1	-1	-7	-9	-10	-7	-3	-1	-39	
life stage		juv	juv	e & l	e & l	e & l, juv	l & juv	juv	juv		

CALFED Alternatives evaluation for striped bass -page 3

Diversion Effects on Striped Bass-Alternative 2

Effects	wt.	Oct-Nov	Dec- Mar	Apr.	May	June	July	Aug	Sep		comments
Entrainment	10	-1	-1	[illegible]	[illegible]	[illegible]	-4	-1	-1		Losses due to Mokelumne spawning location
Predation mortality-CCF & release											shaded cells indicate change from existing conditions
Entrainment losses											
Handling mortality											
Food supply	3	0	0	0	0	-1	-1	-1	0		
Shallow/inshore habitat- offsetting div.	1	0	0	0	0	0	0	0	0		No effect on striped bass predicted. High uncertainty.
Water quality (toxics)	1	0	0	0	0	-1	0	0	0		
WQ (salinity) affecting SJR spawning	1	0	0	-1	-1	0	0	0	0		
Agricultural diversions	3	0	0	-1	-2	-2	-1	0	0		
Hydrodynamics-Sacramento R. trans	3	0	0	[illegible]	[illegible]	[illegible]	0	0	0		
Hydrodynamics-San Joaquin flow	3	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		Positive downstream flows April-July; Lower flows in July-Aug
Hydrodynamic- Xdel fl- G. sl and 3 mi.	3	0	0	[illegible]	[illegible]	[illegible]	0	-1	0		adults spawning in Mokelumne River
Unweighted total		-1	-1	-8	-13	-11	-7	-4	-1	-46	
life stage		juv	juv	e & l	e & l	e & l, juv	l & juv	juv	juv		adults affected by screen barrier to spawning areas

Diversion Effects on Striped Bass- Alternative 3.

Effects		Oct-Nov	Dec- Mar	Apr	May	June	July	Aug	Sep		comments
Entrainment	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		shaded cells indicate change from existing conditions
Predation mortality-CCF & release											
Entrainment losses											
Handling mortality											
Food supply	3	0	0	0	0	-1	-1	-1	0		
Shallow/ nearshore habitat	1	0	0	0	0	0	0	0	0		
Water quality (toxics)	1	0	0	0	0	-1	0	0	0		
WQ (salinity) affecting SJR spawning	1	0	0	-1	-1	0	0	0	0		
Agricultural diversions	3	0	0	-1	-2	-2	-1	0	0		
Hydrodynamics-Sacramento R. trans	3	0	0	[illegible]	[illegible]	[illegible]	0	0	0		
Hydrodynamics-San Joaquin flow	3	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		
Hydrodynamic- Xdel fl- G. sl and 3 mi.	3	0	0	[illegible]	[illegible]	[illegible]	0	0	0		
Unweighted total		2	2	-2	-8	-6	3	3	2	-4	
life stage		juv	juv	e & l	e & l	e & l, juv	l & juv	juv	juv		

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Diversion Effects on Striped Bass - Restoration conditions

Effects	wt.	Oct-Nov	Dec- Mar	Apr	May	June	July	Aug	Sep		comments
Entrainment	10	2	2	5	5	5	5	4	3		June to Aug more predation on juveniles.
Predation mortality-CCF + return											shaded cells indicate change from existing conditions
Entrainment losses											
Handling mortality											
Food supply	3	[illegible]	0	2	2	2	2	2	1		
Shallow/inshore habitat- offsetting div.	1	0	0	0	0	0	0	0	0		
Water quality (toxics)	1	[illegible]	1	1	1	[illegible]	[illegible]	1	1		
WQ (salinity) affecting SJR spawning	1	0	0	1	1	1	0	0	0		
Agricultural diversions	3	0	0	1	2	2	1	0	0		
Hydrodynamics-Sacramento R. trans	3	0	0	3	3	3	0	0	0		
Hydrodynamics-San Joaquin flow	3	0	0	2	2	2	2	2	0		
Hydrodynamic- Xdel fl- G. sl and 3 mi.	3	0	0	1	1	1	0	0	0		
Unweighted total		4	3	14	13	13	9	9	5	70	
life stage		juv	juv	e & l	e & l	e & l, juv	l & juv	juv	juv		

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Matrix for Calfed

CALFED Alternatives evaluation for striped bass -page 5--Weighted Results

Diversion Effects on Striped Bass-Existing conditions assumes Delta Accord

Effects	wt.	Oct-Nov	Dec- Mar	Apr	May	June	July	Aug	Sep	sum	comments
Entrainment	10	-10	-10	-20	-30	-30	-40	-20	-10	-170	June to Aug more predation on juveniles.
Predation mortality-CCF + return											
Entrainment losses											
Handling mortality											
Food supply	3	0	0	0	0	-3	-3	-3	0	-9	Diversion effects on zooplankton appear small
Shallow/inshore habitat- offsetting div.	1	0	0	0	0	0	0	0	0	0	
Water quality (toxics)	1	0	0	0	0	-1	0	0	0	-1	
WQ (salinity) affecting SJR spawning	1	0	0	-1	-1	0	0	0	0	-2	
Agricultural diversions	3	0	0	-3	-6	-6	-3	0	0	-18	Diversions vary with water year type.
Hydrodynamics-Sacramento R. trans	3	0	0	-3	-3	-3	0	0	0	-9	
Hydrodynamics-San Joaquin flow	3	0	0	-3	-3	-6	-6	-6	-3	-27	Diversions vary with water year type.
Hydrodynamic- Xdel fl- G. sl and 3 mi.	3	0	0	-3	-3	-3	0	-3	0	-12	
Weighted total		-10	-10	-33	-46	-52	-52	-32	-13	-248	
life stage		juv	juv	e & l	e & l	e & l, juv	l & juv	juv	juv		

Diversion Effects on Striped Bass- No Action--Weighted Results

Effects		Oct-Nov	Dec- Mar	Apr	May	June	July	Aug	Sep	sum	comments
Entrainment	10	-10	-20	-20	-30	-30	-40	-20	-10	-180	shaded cells indicate change from existing conditions
Predation mortality-CCF											
Entrainment losses											
Handling mortality											
Food supply	3	0	0	0	0	-3	-3	-3	0	-9	
Shallow/ nearshore habitat	1	0	0	0	0	0	0	0	0	0	
Water quality (toxics)	1	0	0	0	0	-1	0	0	0	-1	
WQ (salinity) affecting SJR spawning	1	0	0	-1	-1	0	0	0	0	-2	
Agricultural diversions	3	0	0	-3	-6	-6	-3	0	0	-18	
Hydrodynamics-Sacramento R. trans	3	0	0	-3	-3	-3	0	0	0	-9	
Hydrodynamics-San Joaquin flow	3	0	0	-3	-3	-6	-6	-6	-3	-27	
Hydrodynamic- Xdel fl- G. sl and 3 mi.	3	0	0	-3	-3	-3	0	-3	0	-12	
Weighted total		-10	-20	-33	-46	-52	-52	-32	-13	-258	
life stage		juv	juv	e & l	e & l	e & l, juv	l & juv	juv	juv		

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Diversion Effects on Striped Bass-common programs --Weighted Results

Effects	wt.	Oct-Nov	Dec- Mar	Apr	May	June	July	Aug	Sep	sum	comments
Entrainment	10	0	0	0	0	0	0	0	0	0	shaded cells indicate change from existing conditions
Predation mortality-CCF											
Entrainment losses											
Handling mortality											
Food supply	3	0	0	0	0	0	0	0	0	0	
Shallow/inshore habitat- offsetting div.	1	0	0	0	0	0	0	0	0	0	difficult to assess for striped bass/ need more info.
Water quality (toxics and nutrients)	1	0	0	0	0	0	0	0	0	0	water quality for drinking water not necessarily good for fish
WQ (salinity) affecting SJR spawning	1	0	0	0	0	0	0	0	0	0	
Agricultural diversions	3	0	0	0	0	0	0	0	0	0	
Hydrodynamics-Sacramento R. trans	3	0	0	0	0	0	0	0	0	0	
Hydrodynamics-San Joaquin flow	3	0	0	0	0	0	0	0	0	0	
Hydrodynamic- Xdel fl- G. sl and 3 mi.	3	0	0	0	0	0	0	0	0	0	
Weighted total		0	0	0	0	0	0	0	0	0	
life stage		juv	juv	e & l	e & l	e & l, juv	l & juv	juv	juv		

Diversion Effects on Striped Bass- Alternative 1--Weighted Results

Effects		Oct-Nov	Dec- Mar	Apr	May	June	July	Aug	Sep	sum	comments
Entrainment	10	-10	-10	-20	-30	-20	-30	-10	-10	-140	shaded cells indicate change from existing conditions
Predation mortality-CCF											
Entrainment losses											
Handling mortality											
Food supply	3	0	0	0	0	-3	-3	-3	0	-9	
Shallow/ nearshore habitat	1	0	0	0	0	0	0	0	0	0	
Water quality (toxics)	1	0	0	0	0	-1	0	0	0	-1	
WQ (salinity) affecting SJR spawning	1	0	0	-1	-1	0	0	0	0	-2	
Agricultural diversions	3	0	0	-3	-6	-6	-3	0	0	-18	
Hydrodynamics-Sacramento R. trans	3	0	0	-3	-3	-3	0	0	0	-9	
Hydrodynamics-San Joaquin flow	3	0	0	-3	-3	-6	-6	0	0	-18	
Hydrodynamic- Xdel fl- G. sl and 3 mi.	3	0	0	-3	-3	-3	0	-3	0	-12	
Weighted total		-10	-10	-33	-46	-42	-42	-16	-10	-209	
life stage		juv	juv	e & l	e & l	e & l, juv	l & juv	juv	juv		

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Diversion Effects on Striped Bass-Alternative 2 --Weighted Results

Effects	wt.	Oct-Nov	Dec- Mar	Apr	May	June	July	Aug	Sep	sum	comments
Entrainment	10	-10	-10	-30	-40	-20	-40	-10	-10	-170	June to Aug more predation on juveniles.
Predation mortality-CCF & release											shaded cells indicate change from existing conditions
Entrainment losses											
Handling mortality											
Food supply	3	0	0	0	0	-3	-3	-3	0	-9	
Shallow/inshore habitat- offsetting div.	1	0	0	0	0	0	0	0	0	0	No effect on striped bass predicted. High uncertainty.
Water quality (toxics)	1	0	0	0	0	-1	0	0	0	-1	
WQ (salinity) affecting SJR spawning	1	0	0	-1	-1	0	0	0	0	-2	
Agricultural diversions	3	0	0	-3	-6	-6	-3	0	0	-18	
Hydrodynamics-Sacramento R. trans	3	0	0	-6	-12	-9	0	0	0	-27	
Hydrodynamics-San Joaquin flow	3	0	0	6	3	3	-3	-3	0	6	Positive downstream flows April-July;+K22 Lower flows in July-
Hydrodynamic- Xdel fl- G. sl and 3 mi.	3	0	0	-9	-9	-9	0	-3	0	-30	adults spawning in Mokelumne River
Weighted total		-10	-10	-43	-65	-45	-49	-19	-10	-251	
life stage		juv	juv	e & l	e & l	e & l, juv	l & juv	juv	juv		adults affected by screen barrier to spawning areas

Diversion Effects on Striped Bass- Alternative 3 --Weighted Results

Effects		Oct-Nov	Dec- Mar	Apr	May	June	July	Aug	Sep	sum	comments
Entrainment	10	20	20	-10	-30	-10	40	30	20	80	shaded cells indicate change from existing conditions
Predation mortality-CCF & release											
Entrainment losses											
Handling mortality											
Food supply	3	0	0	0	0	-3	-3	-3	0	-9	
Shallow/ nearshore habitat	1	0	0	0	0	0	0	0	0	0	
Water quality (toxics)	1	0	0	0	0	-1	0	0	0	-1	
WQ (salinity) affecting SJR spawning	1	0	0	-1	-1	0	0	0	0	-2	
Agricultural diversions	3	0	0	-3	-6	-6	-3	0	0	-18	
Hydrodynamics-Sacramento R. trans	3	0	0	-6	-12	-9	0	0	0	-27	
Hydrodynamics-San Joaquin flow	3	0	0	6	3	3	3	3	0	18	
Hydrodynamic- Xdel fl- G. sl and 3 mi.	3	0	0	3	3	3	0	0	0	9	
Weighted total		20	20	-11	-43	-23	37	30	20	50	
life stage		juv	juv	e & l	e & l	e & l, juv	l & juv	juv	juv		

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Diversion Effects on Striped Bass - Restoration conditions --Weighted Results

Effects	wt.	Oct-Nov	Dec- Mar	Apr	May	June	July	Aug	Sep	sum	comments
Entrainment	10	20	20	50	50	50	50	40	30	310	June to Aug more predation on juveniles.
Predation mortality-CCF + return											shaded cells indicate change from existing conditions
Entrainment losses											
Handling mortality											
Food supply	3	3	0	6	6	6	6	6	3	36	
Shallow/inshore habitat- offsetting div.	1	0	0	0	0	0	0	0	0	0	
Water quality (toxics)	1	1	1	1	1	1	1	1	1	8	
WQ (salinity) affecting SJR spawning	1	0	0	1	1	1	0	0	0	3	
Agricultural diversions	3	0	0	-3	-6	-6	-3	0	0	-18	
Hydrodynamics-Sacramento R. trans	3	0	0	9	9	9	0	0	0	27	
Hydrodynamics-San Joaquin flow	3	0	0	6	6	6	6	6	0	30	
Hydrodynamic- Xdel fl- G. sl and 3 mi.	3	0	0	3	3	3	0	0	0	9	
Weighted total		24	21	73	70	70	60	53	34	405	
life stage		juv	juv	e & l	e & l	e & l, juv	l & juv	juv	juv		

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